CATAPULT FOR EJECTING A PARACHUTIST

The present invention relates to a catapult, particularly for launching a parachutist.

The war machines of antiquity were operated by springs of horsehair, horn, dry leather, hair, or gut. The word "catapult", which means "armor piercer" was used to describe some of these giant crossbows.

Their low power and poor resistance to humidity caused them to be abandoned in the Middle Ages for machines consisting of a long and strong piece of wood called a rod articulated on a horizontal axis at (for example) one quarter of its length. A counterweight is attached or articulated to the short arm of this rod. The projectile is contained in a pouch coupled to a strong iron point called a stylus, in the extension of the long arm. The rotation of the rod under the action of the counterweight causes the pouch to rotate around the stylus, and its release at a point of its complex trajectory depends on the ratio of the radii of the arcs of circles described by the stylus and the projectile and on the ratio of the weights of the counterweight and the projectile.

These machines coexisted with artillery until the arrival of the metal cannonball. They were sometimes used to catapult prisoners from one side to the other of the ramparts of besieged citadels, but these must be seen more as cruel episodes of psychological warfare than the birth of an aerial sport.

The ejector seat that catapults the pilot to a safe distance from his doomed airplane is a rocket. The catapult that launches aircraft from an aircraft carrier is operated by an enormous steam cylinder. It

is known that, in the 1930s, the Russians tried to catapult parachutists by blowing into their open canopies with giant propellers. They achieved only disappointing performance.

In the beginning, parachuting was a fairground attraction. It found a use a century later with the invention of the airplane, as an apparatus of safety and sport. Parachute jumps are usually made at an altitude of several thousand meters and the spectacle aspect of this activity has truly lost some of its immediacy.

For some twenty years, a new sport has branched off from parachuting: BASE jumping. It involves parachuting from a fixed object: a Building, an Antenna, a bridge (Spanner) or a cliff (Earth). Special, single-canopy parachutes, that open quickly and effectively, have been developed for this activity. It is quite usual nowadays to parachute jump from heights of less than 100 meters.

The BASE jump has moved closer to the public but it requires a fixed object, of sufficient height, allowing the sportsman to jump while having sufficient time to open his parachute.

The object of the invention is, in particular, to propose a catapult designed to launch a man or a woman from the ground to a sufficient height to allow them to descend again by parachute.

According to the invention, a catapult, in particular for launching a parachutist, is characterized in that it comprises a flexible or articulated cradle containing the parachutist and connected to two fast runs, passing over two pulleys placed high up, at least one pulley block supporting a counterweight, the parachutist being catapulted into the air when the

catapult is released and the counterweight falls.

The counterweight may be held by two pulley blocks, the fast runs of the pulley blocks being connected to the cradle. The ratio of the pulley block or blocks may be approximately 10.

The body of the parachutist may be substantially perpendicular to the direction of movement of the gondola. The fast runs may be held in tension before the catapult is released.

The cradle may be opened at the end of travel by the pull of the runs. The cradle may be stopped at the end of travel by its aerodynamic drag.

The catapult may be stopped by stopping the fall of the counterweight, in particular by making contact with the ground. The travel of the counterweight may be approximately 5 meters.

The cables used for producing the fast runs may be made of material with a low mass per unit length.

According to another aspect, the catapult is characterized in that it comprises a flexible or articulated cradle for containing a load to be ejected, in particular a parachutist, coupled to two runs of flexible line, passing over two pulleys placed high up, connected to at least one exit of a means with a travel multiplier factor, the entrance of the multiplier means being controlled by the fall of a counterweight whose mass is selected to be large enough for the acceleration transmitted to the load to be a multiple of the acceleration due to gravity, the load being catapulted into the air when the catapult is released and the counterweight falls.

Other features and advantages of the invention will

appear in the description that follows with reference to the appended drawings but implying no limitation.

In these drawings:

fig. 1 is a view in perspective of an embodiment of a catapult according to the invention;

fig. 2 is a view in perspective of an embodiment of a catapult cradle according to the invention.

Two pulleys A and B are suspended. There is nothing between them, neither cable nor yard. They may be suspended from appropriate buildings, such as two twin towers or an ad hoc structure. They may also be suspended from two cranes, as in the illustration, 60 meters high for example, the distance between them being ten or so meters.

Over these pulleys pass the fast runs of a double pulley block C, coupled to a third crane. This crane, shorter, placed facing the other two, supports a counterweight D, weighing between 15 and 30 tons, suspended from this double pulley block.

It should be noted that substantially different values in the rolling resistances in the pulley blocks would risk creating an acceleration differential between the two fast runs and cause the shot to deviate. Such a deviation could be harmful from the point of view of the parachutist's safety. Using a double pulley block makes it possible, amongst other things, to substantially reduce this risk.

This double pulley block C consists of two elements each comprising two blocks each consisting of 10 or 12 large-diameter pulleys mounted on ball bearings on a shaft. On these pulleys are rigged two light synthetic fiber ropes, which therefore make it possible to obtain multipliers of up to 12 on two separate runs.

The choice of a high multiplier makes it possible in theory to obtain a greater acceleration but tests have shown that the impact of the friction and inertia of the device greatly limits the reduction ratio that can be used. In this context, a multiplier of 10 is a worthwhile compromise.

The counterweight will weigh 15 tons but this weight may advantageously be increased so as to allow the parachutist to reach a greater height and allow him to open his parachute in the best conditions.

These runs, after passing over the pulleys A and B, come to be attached to slings sewn into a flexible cradle E that holds the body of the parachutist. The angle formed with the vertical by the portion of the runs extending between the pulleys A, B and the cradle E is small, usually less than 30°, preferably less than 20°.

This cradle consists of a piece of strong canvas approximately 2 meters long, 1 meter wide. It is held taut in the longitudinal direction by an appropriate battening or a sheet of flexible plastic and covered with elastic foam inside. Two coupling points F and G are formed from the meeting of several slings sewn onto the cradle. This arrangement makes it possible to minimize the weight of the cradle and therefore its inertia.

Two strong slings I and J extend downwards on either side of the coupling points, are connected together beneath the keel by a tube K performing the function of a spreader, and meet one another in the retaining loop L, designed to receive the rapid-release system (of the "3 rings" type, for example).

The two ends of the cradle may be connected to this

loop L by adjustable slings M and N to adjust the trim of the parachutist at the moment of departure.

In the firing position, the cradle containing the parachutist is coupled via its loop L to the release system, itself attached to the ground, for example to a stabilizer leg of one of the tall cranes. Consequently, the system is under tension before the firing and that makes it possible substantially to prevent the parachutist being subjected to an impact when the shot is released.

The counterweight is suspended from its pulley block at a height such that it will touch the ground when the cradle is at the top end of its travel. The static tension in the fast runs of the pulley block, connected to the cradle at F and G, is then equal to the weight of the counterweight divided by the reduction ratio of the pulley block; the travel of the counterweight will be equal to that of the cradle divided by the reduction ratio of the pulley block. Such a system makes it possible to exert a constant acceleration on the cradle, unlike, for example, when using elastic parts.

The parachutist is lying down in the cradle, facing the sky. The lying position, adopted for astronaut launch, makes it possible to eliminate the risks of problems due to the effects of the acceleration on the movements of the blood (pilot "blackout"). Accelerations of this order of magnitude are already experienced by the users of certain fairground attractions and will be bearable for the parachutist.

Furthermore, it should be noted that using a flexible gondola, which consequently deforms, makes it possible to prevent having too great an acceleration gradient at the start.

At the end of travel, the cradle, carried on by its

inertia, risks causing the fast runs to come out of their housings on the pulleys. Pulleys furnished with anti-derailment systems will therefore be used. This type of system is already known to those skilled in the art.

In operation, when the release system is triggered, the parachutist in his flexible cradle is carried speedily upward by the fall of the counterweight, at a speed multiplied by the pulley block.

A counterweight M, for example weighing 12 tons subjected to the Earth's gravity, pulls, through the double pulley block whose blocks comprise n pulleys, the mass (m = 100 kg) of the gondola and transmits an acceleration γ to the latter, where:

$$m\gamma = Mg/n - mg \Rightarrow \gamma = (M/m/n - 1)g.$$

An acceleration γ that is considered bearable is $\gamma = 5g$, g being the gravitational acceleration. To take account of the friction and a safety margin, it may be considered that the counterweight descends in a uniform movement accelerated at approximately 0.5g only. To obtain an acceleration $\gamma = 5g$, a reduction ratio of n = 10 should be chosen.

The pulley block being constructed in a ratio of 10, the gondola will be propelled upward with a constant acceleration of $\gamma = 5g$.

The speed achieved by the parachutist over the travel (h = 40 m) will allow him to reach an altitude H such that:

$$H = h \times (1 + \gamma/g) = 240 \text{ m}.$$

Half of this altitude is sufficient to allow a rapid-opening parachute to deploy safely.

The parachutist will therefore be launched face upward,

inclined for example at 30° to the horizon, with the feet below the head. He will have to tilt 150° forward (or 210° backward) after leaving the catapult to be in a horizontal position face down for the parachute to open.

In the last part of the ascent, the pull of the runs opens out the cradle, releasing the parachutist, who continues his upward travel when the counterweight touches the ground. The open cradle is then stopped by its aerodynamic drag.

The catapult according to the invention will be a new aerial sport. It will make possible parachuting demonstrations close to the public, the learning of BASE jumping in new safety conditions, flights in winged suits, and BASE jumps without cliffs.

The foregoing description essentially mentions a double pulley block as the simple and effective travel multiplier means. However, other multiplier means, particularly gear sets, could be envisaged.

The catapult is not limited to launching a parachutist since other loads could naturally be launched.